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NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER BETHESDA MD
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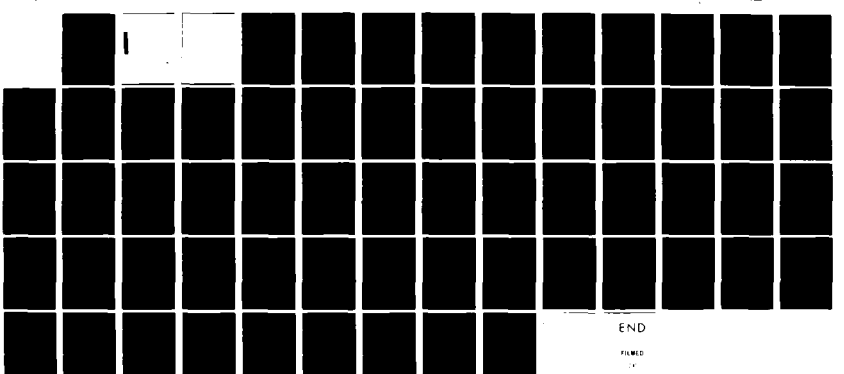

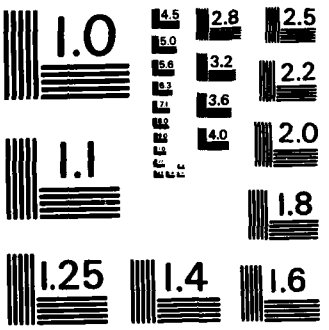

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SAILS simulates the movement of cargo between ports of interest. It accumulates cargo available, shipped, and delivered by cargo type and required delivery dates. Ship status and volume utilization reports are computed on a ship-operation basis. Convoys of ships are also considered.

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ABSTRACT

SAILS simulates the movement of cargo between ports of interest. It accumulates cargo available, shipped, and delivered by cargo type and required delivery dates. Ship status and volume utilization reports are computed on a ship-operation basis. Convoys of ships are also considered.

ADMINISTRATIVE INFORMATION

This sub-task was funded by the Maritime Affairs and Support Plans Branch (OP-405) with OM&N funds. The work was performed by the Logistics Planning Group (Code 1871) in the Computations, Mathematics, and Logistics Department of the David Taylor Naval Ship Research and Development Center, Carderock, Maryland under Work Unit 1870-041.

INTRODUCTION

SAILS is a computer simulation of cargo movement between ports of interest. It is essentially a revision of the REACT (Requirements Evaluated Against Cargo Transportation) simulation model developed by Research Associates Incorporated for the Integrated Sealift Study. SAILS is designed to eliminate the difficulties and inconsistencies encountered in the use of the REACT model, which included loss of cargo shipment identity and sometimes unreasonable cargo and ship assignments. SAILS uses the simulation logic of REACT, tempered with a linked list data retrieval method to reduce computer storage and program running time.

SAILS determines a feasible ship mix which will satisfy both cargo delivery requirements and ship utilization restrictions for a specified scenario. This simulation allows the user to vary cargo movement and ship utilization results by changing input parameters for the same scenario. Some of the parameters which affect output variance include

- Perferred ship types
- Ship initialization and positioning at ports
- Preferred port facility types
- Convoy operations
- Backlogged cargo shipment requirements

SAILS generates a series of summaries at simulation time intervals specified by the user. Each summary shows the amount of cargo available at a port, shipped from a port, and delivered to a port, and the utilization and status of each ship used. A histogram of cargo shipped and delivered by the current mix of ships is also generated.

SAILS is a stochastic program which can predict a feasible mix of ships which can deliver the needed cargo by a required date.

SIMULATION ELEMENTS

SAILS traces the movement of ships and cargo among ports for a given scenario. The elements of this simulation are theaters, ports, berth queues, cargo, ships, ship pools, and convoys. The following paragraphs describe the role of each element in the simulation.

THEATERS

A theater is a group of ports which is treated as a single port, but in which each port in the group retains its individual characteristics. A theater also defines the geographical location of the group of ports.

PORTS

Ports are represented as facilities which transfer cargo. Each port has a geographical location. The relationship between ports is expressed in a table of travel times.

Each port has the following characteristics which determine the ships it is able to service:

- draft (ft)
- entrance/exit transit time (delays)
- unloading/loading facilities (berths)
- theater

A port may have up to six berth or facility types and up to 99 facilities of each type. Associated with each berth type is a cargo handling rate.

BERTH QUEUES

Each port has a number of berths of each type. When the number of arriving ships exceeds the number berths available at a port, the ships that cannot be assigned berths are placed in a queue. As the facilities become available, these ships are removed from the queue on a first in, first out basis and serviced at the port facility.

CARGO

Cargo is accumulated on its availability date at its origin port, that is, port of embarkation (POE). Each cargo entry includes the cargo type,

quantity (measurement tons), port of debarkation (POD) and required delivery date. Cargo information is developed by the Joint Services from a given operations plan (OPLAN) for a specified scenario. The deployment force readiness represented by the scenario dictates the cargo availability date at its POE and the required delivery date at its POD. SAILS considers the nine cargo types given in Table 1.

TABLE 1 - CARGO TYPES

Cargo Type	Class Description
1	General
2	Special (Heavy Lift)
3	Ammunition
4	POL
5	Aircraft
6	Boats
7	Containers
8	Containers (Heavy Lift)
9	Undefined

SHIPS

Up to 1000 ships may be represented in the simulation. Ships are grouped by physical characteristics, such as draft, volume, speed, and cargo type preference. Such a grouping is referred to as a ship type. SAILS can accommodate the 16 ship types described in Table 2.

TABLE 2 - SHIP TYPES AND THEIR CHARACTERISTICS

Ship Type	Ship Type Name	Capacity (measurement tons)	Average Speed (knots)	Cargo Types Carried
1	BBS	10286	17.0	1,2,3,4,6
2	BBF	11729	20.7	1,2,3,5,6,7,8
3	ROROS	11803	17.4	2,3,5
4	ROROF	21905	23.5	7,8
5	SSCS	21106	17.4	7,8

TABLE 2 (Continued)

Ship Type	Ship Type Name	Capacity (measurement tons)	Average Speed (knots)	Cargo Types Carried
6	SSCF	18200	17.0	1,2,3,4,6
7	NSSCS	18311	17.7	7,8
8	NSSCF	25907	23.2	7,8
9	COMBS	16721	17.4	1,3,7,8
10	COMBF	23311	23.6	1,2,3,5,7,8
11	LASH	25907	21.9	1,2,3,5,6,7,8
12	STRHV	12786	16.2	1,2,3,5,6
13	STRNSS	13584	16.0	1,2,4,5,6
14	SEABEE	3100	16.0	1,2,3,5,6,7,8
15	TANKSM	27500	20.0	4
16	TANKMD	54083	14.9	4

SHIP POOL

Provision is made in the model for a pool of ships. Ships enter the pool for one of two reasons: (1) they are input initially as being in the pool (this feature may be useful in representing the availability of a reserve fleet on a delayed basis allowing the model to initially position ships at ports with waiting cargo, and (2) on normal operation they enter the pool because cargo which they are able to carry is not available. Ships entering the pool may either return to their initial ports or remain at their last ports of entry (input option) until sufficient cargo becomes available.

CONVOYS

A convoy is a group of ships sailing between two theaters at the same time and at the same speed. Convoy specifications such as origin and delivery theaters, maximum convoy formation time, and the desired number of ships in the convoy are input by the user.

SIMULATION LOGIC

SAILS is an event storing simulation. Such a model is based on the sequential processing of a list of procedures, each of which occurs at a stated time.

Such procedures are called events. To begin the simulation, initial events are placed on the list (stored) at the beginning of the simulation, and they in turn place other events of the same or different type on the list.

EXAMPLE: The following initial events are placed on the list for processing:

- Accumulate cargo at the POE's with availability time = 1.00 day
- Ship arrives at port at time = 1.50 days
- Terminate run at time = 7.00 days

Cargo accumulation is performed daily. Arrival of a ship at a port establishes the unloading and loading cycles and the selection of the next port of call. Table 3 illustrates a complete event list. (Travel, unloading, and loading times are given in Table 3 by way of example and do not represent a real case.)

TABLE 3 - COMPLETE EVENT LIST

TIME (DAYS)	EVENT
1.00	Cargo Accumulation at POE's
1.50	Arrival of ship
2.00	Cargo Accumulation at POE's
2.00	Unloading cycle for this ship
3.00	Cargo Accumulation at POE's
3.00	Loading cycle for this ship
4.00	Cargo Accumulation at POE's
5.00	Cargo Accumulation at POE's
5.50	Arrival of ship at next port of call
6.00	Cargo Accumulation at POE's
6.00	Unloading cycle for this ship
7.00	End simulation

Cargo accumulation at POE's, ship berthing facility assignment, unloading and loading operations, next port of call selection, ship queueing at berths, ship pool operations, and convoy operations expressed or implied in Table 3 are briefly described.

CARGO ACCUMULATION AT THE POE

Cargo is accumulated at the POE according to the OPLAN of the selected scenario. Cargo availability times at the POE's are computed from the required delivery date (RDD) at the POD's less the time of handling and shipping from the POE.

Each cargo entry, given as input, specifies the availability time at the POE and required delivery time at the POD. If the current simulation time is greater than or equal to the availability time of the cargo at the POE, that cargo is available for shipment.

SHIP BERTHING FACILITY ASSIGNMENT

When a ship enters a port, the ship's time of availability is updated, and its berthing facility type preference is determined. A ship may have at most two preferred berth types. Berth type preferences for each ship type are set in the program. A scan of all the berths available at the entry port is made. If a berth of the ship's first preferred type is available, the berth is assigned to the ship. If no berths of the ship's first preferred type are available, and a second preferred type is given and a berth of the second preferred type is available, it is assigned to the ship. Otherwise, the ship enters a berth queue at the entry port.

If no berth type preference is given for the ship, an available berth with the greatest productivity is assigned to the ship. If no berths are available, the ship enters a berth queue at the entry port.

Since a ship entering a port must be towed into the berth area and connected to berthside utilities, a delay time for the ship to enter or leave port must be considered by the simulation. The simulation time is updated by this delay time, and unloading and loading operations commence.

UNLOADING AND LOADING OPERATIONS

Cargo intended for the port is off-loaded first. The transfer time is determined from the measurement tons (mt) of cargo moved and a transfer rate (days per measurement ton). Transfer rates are given with respect to berthing facility and cargo types. Both unloading and loading operations use these transfer rates to compute cargo transfer times.

Transfer rates may be individualized for each port by using an adjustment factor which, when multiplied by the transfer rate, either increases or reduces cargo handling times. The simulation time is updated as each cargo item is off-loaded.

When unloading operations are complete, loading begins. All cargo available at the port is scanned, and the quantities of waiting cargo are summed for each port. Only cargo with delivery ports within a given travel range of the POD's of the on-board cargo is considered. The port with a minimum of 1000 measurement tons of cargo and the greatest ratio of measurement tons of cargo to travel time to the port is selected as the delivery port. This is done to ensure that the nearest ports with the most available cargo are visited first. A requirement of a minimum of 1000 measurement tons prevents the inefficient alteration of a ship's schedule. Waiting cargo intended for this delivery port is loaded aboard the ship. Transfer time is computed from the quantity of cargo loaded and the transfer rate, and the simulation time is updated by the transfer time.

When the ship is sufficiently utilized (at least 60%* full) or when it has been in port for at least six simulation days, it will sail for the next port of call.

NEXT PORT OF CALL SELECTION

When a ship leaves a port, the next port of call must be determined. When the ship is less than 60% utilized, nearby ports are scanned to determine whether any have available cargo destined for the ship's delivery ports (theaters). Of those ports, only the ports with at least 2000* measurement tons of available cargo are considered. Again, a minimum available cargo restriction and a desired ship utilization requirement are used to prevent inefficient ship scheduling. The next port of call is the port which has the greatest ratio of measurement tons of backlogged cargo to travel time to the nearby port.

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*These values were determined by varying cargo movement restrictions and may be changed to suit the users.

If the ship is more than 60% utilized or if no nearby port meets the selection criteria, the ship's next port of call is determined from its carried cargo. The POD nearest the ship's current port is selected.

If the ship is empty and nearby ports do not have sufficient cargo, the ship's next port of call is either its last port or its initial port (determined by input).

SHIP QUEUEING AT BERTHS

A ship enters a berth queue when berthing facilities are not available and leaves the queue when a preferred facility is free for service. Ships leave the queue in a first in, first out manner. The time the ship spends in the queue is computed as the difference between the ship's current availability time and the time at which the berth becomes free for reassignment. Once the berth assignment is made, the simulation time is updated by the ship's berth entrance time and unloading and loading operations begin.

SHIP POOL OPERATIONS

Ships enter the ship pool for one of two reasons; either they are placed in the pool as an input option or they were inactivated because of insufficient available cargo.

The amount of cargo backlogged at each port is accumulated daily. If the amount of cargo at any port is greater than or equal to the cargo that can be handled by one-third of the ships entering the port within two days, ships currently in the pool which are capable of handling the cargo will be activated.

The model tries to initialize cargo movement within two days of its availability at the POE, and at the same time to maintain an acceptable ship utilization. The lowest acceptable utilization is 33%. The numbers of ships to be removed from the pool are determined from the amount of backlogged cargo at a port and the space available on each reserve ship. Ports with the greatest amount of backlogged cargo and the most efficient ships nearest to these ports are considered first. The availability times of the ships are updated to allow positioning at the loading ports. Once these ships are assigned ports to service, they are removed from the ship pool, and port operations begin.

DATA STORAGE AND RETRIEVAL TECHNIQUES

Several techniques were used in the SAILS program to reduce execution time and core requirements. The penalty for the gain in efficiency of the program is increased program complexity. These techniques are described here to help in understanding the program coding. One of these techniques has to do with the calculation of travel times between ports; two are general data storage techniques used to reduce sort times in SAILS.

TRAVEL TIME TECHNIQUES

The SAILS program can simulate cargo handling at up to 99 ports, and the program makes frequent use of the travel times between ports. The times differ for the sixteen ship types, resulting in more than 15,000 inter-port time measurements. The prohibitive cost of storing a collection of data of this magnitude demands that this figure be reduced to a more manageable level; the techniques mentioned address this problem.

The major reduction in the time array sizes is achieved by grouping the ports; each group of ports in close proximity is considered a single port, a theater. (These groupings reflect some functional as well as geographic differentiation.) The travel times between ports within a theater are taken to be constant (two days). Therefore, SAILS considers travel between theaters, not between ports.

A further reduction in the time array sizes is gained by using distance (nautical miles) instead of time and using the ship type speed to determine travel time. This expendient reduces the array size by a factor of sixteen.

The final reduction in array size is based on an assumption of symmetry in the travel time (distance) matrices; i.e., the time to travel from port A to port B is the same as the time to travel from port B to port A. This assumption is justified by actual travel time data collected by the Integrated Sealift Study.

Applying these techniques reduced the arrays from more than 15,000 storage locations to 150, with only a slight increase in the procedural code generated and with little, if any, decrease in accuracy.

LINKED LISTS TECHNIQUES

The use of embedded links is a common method of processing large amounts of data. Several of the large data base management systems now commercially available use this technique in which a sequence of data items in a large set of data arrays is linked together by providing an array of pointers or links. The pointer associated with a data element gives the address of the next datum in the sequence. A pointer external to the arrays gives the address of the first element in the sequence, the link variable associated with that element gives the address of the second element in the sequence, etc. The advantage of this procedure is that the time constraints of sorting, where n^2 movements are required to sort n elements, are not encountered. The introduction of an additional array of pointers does not usually involve a significant increase in storage, since the data elements being sorted are often made up of corresponding components of many parallel arrays (or the addresses of indices in the pointer array are much smaller than the items which they label). The method of data restructuring is illustrated in Figure 1.

Another major advantage to the linked list method of data organization is that it speeds access to the data. For example, instead of searching an entire array for a cargo item which is on a specific ship, only the cargo items on the ship need be examined. The data examination process is made more efficient in SAILS by using a separate linked list for unmoved cargo, i.e., those orders not yet assigned to a ship. As ships are loaded, cargo entries pass from the unprocessed linked list to a specific ship's linked list. Thus each successive search of the unprocessed cargo entries takes less time.

The savings in space and time of the linked list system must be paid for by increased complexity of the program code.

A separate linked list must be maintained if the arrays are to be searched in reverse order, or if items are to be inserted into a list. Thus two link arrays must usually be specified to determine a linear chain of items.

DATA PACKING

Because of the limited size of the cargo entry information and the limited number of ports considered, all cargo information could be placed, "packed", in one data location. The array INFO represents all cargo information, and each entry has the following format:

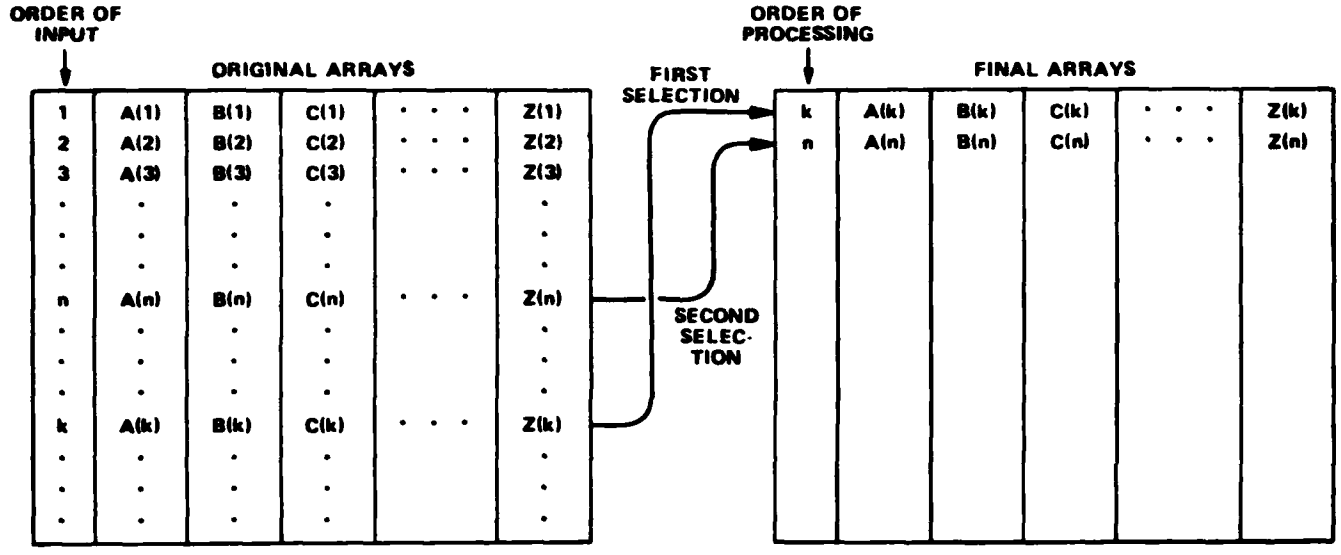

Figure 1 - A Method of Data Storage, Linked Lists

INFO Word Configuration:

Order allocation indicator +, unassigned -, assigned	Cargo type	Origin port number	Destination port number	Order size (mt)
1 digit	1 digit	2 digits	2 digits	7 digits

Data packing also reduces the number of internal sorts by listing one data element rather than four.

COMPUTER RUN INFORMATION

This section describes the input parameters, their definitions and formats, necessary to run SAILS. A brief description of the reports generated by the simulation is also given.

SAILS is written in FORTRAN IV and is designed to run on the CDC 6000 series computers at DTNSRDC. It requires 144K words of memory allocation. A run representing a scenario of 38 theaters and ports, 618 ships, and 4630 cargo entries, simulated for 120 days, required about six minutes of CPU time.

INPUT

Input to SAILS is made available on three files: TAPE1 - cargo file, TAPE2 - ship file, and TAPE5 - standard input file. Figure 2 shows input/output logic.

Cargo File (TAPE1)

Cargo record:

Variable	Cols	Format	Description
IPOD	8-9	I2	Port of Debarkation
IPOE	10-11	I2	Port of Embarkation
TYPE	12	I1	Commodity type
MTS	13-19	I7	Quantity (mt)
EAT	20-23	F4.0	Arrival time at POE (days)
EDD	27-30	F4.0	Earliest delivery time (days)
RDD	31-34	F4.0	Required delivery time (days)

Ship File (TAPE2)

Ship record:

Variable	Cols	Format	Description
SHPTYP	1-3	I3	Ship type
HOME	4-6	I3	Home port
TAVAIL	7-12	F6.0	Availability time (days)
OWNR	13-14	I2	Owner

Card Input (TAPE5)

Run Identification Card (IDENT)

Variable	Cols	Format	Description
IDENT(i), i=1,12	1-72	12A6	Run identification

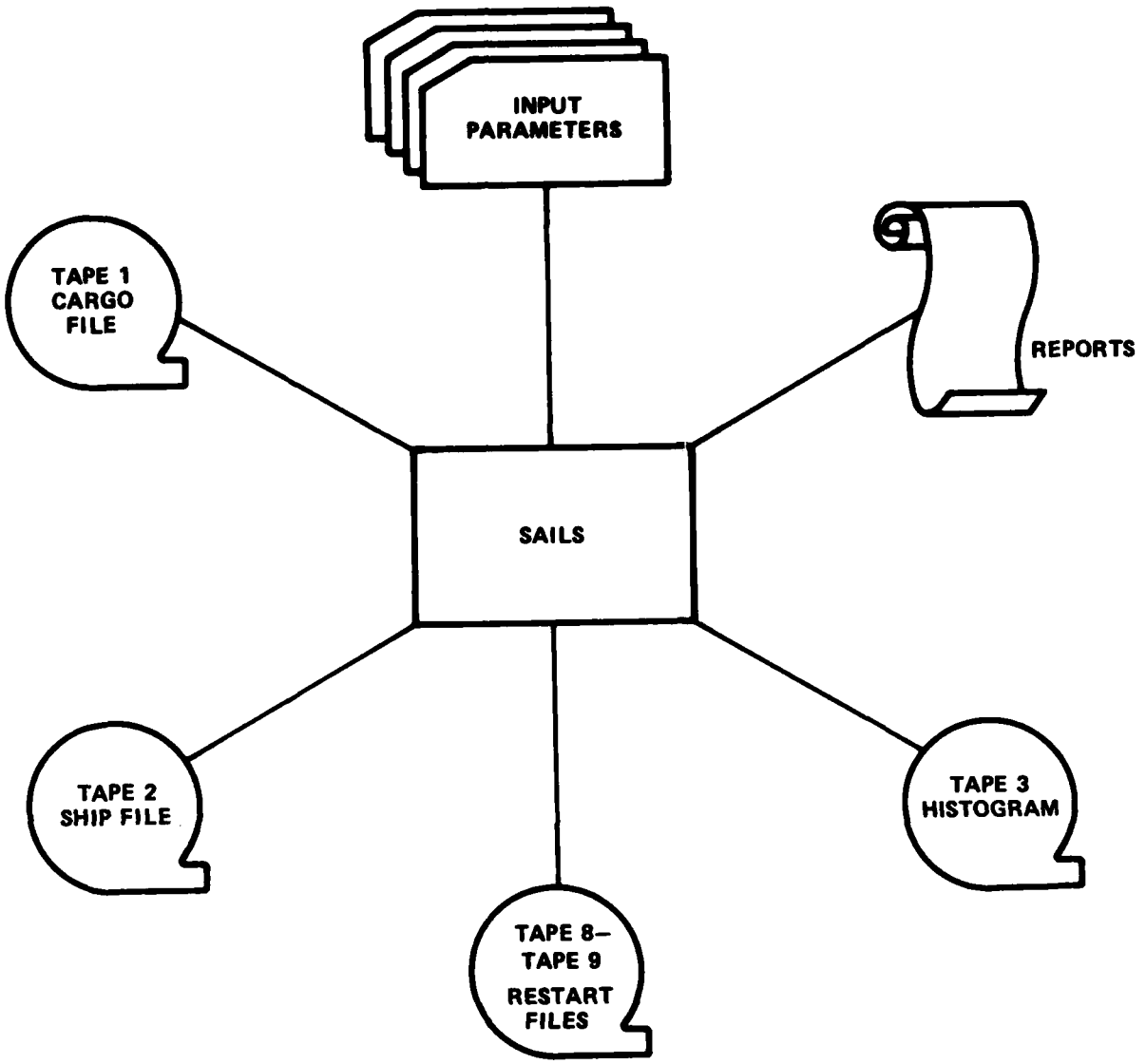

Figure 2 - Input/Output Logic Diagram

General Information Card (GEN)

Variable	Cols	Format	Description
NTHEAS	1-3	I3	Number of theaters
ENDSIM	4-9	F6.0	End time of simulation (days)
TINVL	10-15	F6.0	Start time of ship pool operation (days)

Distance Table Card (DIST)

Variable	Cols	Format	Description
TTIME	1-60	10F6.0	Right diangular half of port distance table (nautical miles)

Convoy Type Card (CNTYP)

Variable	Cols	Format	Description
CONTYP	1-4	I4	Number of convoy types. If the CONTVP card is blank, the CONVY cards are skipped

Convoy Cards (CONVY)

Variable	Cols	Format	Description
MAXC	1-4	I4	Maximum number of ships in this convoy type
MINC	5-8	I4	Minimum number of ships in this convoy type
DTHEA	9-10		Delivery theater
OTHEA	11-12	I2	Origin theater
CWAIT	13-19	F7.1	Time to form convoy (days)
CDEL	20-26	F7.1	Transit time to/from convoy assembly/dispersal location (days)

Port Cards (PORT)

Variable	Cols	Format	Description
PRTNAM	1-6	A6	Port name
THEA	7-9	I3	Theater
FAC_1	10-12	I3	Number of facilities of type 1
FAC_2	13-15	I3	Number of facilities of type 2

Port Cards (PORT)

Variable	Cols	Format	Description
FAC_3	16-18	I3	Number of facilities of type 3
FAC_4	19-21	I3	Number of facilities of type 4
FAC_5	22-24	I3	Number of facilities of type 5
FAC_6	25-27	I3	Number of facilities of type 6
DLYT	28-33	F6.0	Delay time to enter or leave port (days)
ADJF	34-39	F6.0	Adjustment factor used to speed up or slow down loading/unloading operations

Port Omission Card (OMIT)

This card immediately follows each PORT card. One OMIT card per PORT card

Variable	Cols	Format	Description
$OMIT_1$	1-3	I3	Ship type which cannot be serviced by port - maximum of 16 ship types
.	.	.	
.	.	.	
.	.	.	
$OMIT_{16}$	46-48	I3	

OUTPUT

The output of SAILS is divided into three sections:

- Input parameters listing
- Simulation activity reports
- Cargo movement histogram file

Input Parameters Listing

A brief summary of input and run identification is given as a banner page for the simulation activity reports. The numbers of theaters, ports, and ships are printed with the simulation time restrictions and running options.

Simulation Activity Reports

The port and ship summary reports are printed at time intervals supplied by the user. When the simulation has terminated successfully, all the reports are printed. There are five of these reports:

I. Port Summary
II. Ship Summary
III. Cargo Movement Summary
IV. Unmoved Cargo Summary
V. Convoy Summary

Example of these reports are given in the sample run, Appendix A.

Cargo Movement Histogram File

This file gives the movement of each cargo entry. The information contained on this file includes cargo commodity type, availability time at the POE, shipment time from the POE, delivery time at the POD, the RDD at the POD, the EDD at the POD, the carrier ship number, and the POE and POD for each cargo quantity moved. The cargo movement histogram file (TAPE3) has the following record configuration:

Variable	Cols	Format	Description
JOPER	2	I1	Operation indicator =1, loading =2, unloading
SHIP	4-8	I5	Ship number
PORT	9-13	I5	Present port
IPOD	14-18	I5	Delivery port
ITYPE	19-18	I5	Cargo type
QUANTY	24-30	I7	Quantity of cargo moved (mt)
TIME	31-37	F7.1	Current time (days)
GTIME	38-44	F7.1	Time cargo available at POE
GEDD	45-61	F7.1	Earliest delivery time at POD (days)
GRDD	52-58	F7.1	Required delivery time at POD (days)

A COMPARISON OF SAILS TO REACT AND SOS

Three shipping simulations are currently available at DTNSRDC: REACT, SOS, and SAILS. Each attempts to determine a feasible ship mix which will meet the cargo delivery requirements for a given scenario.

REACT[1*] is the oldest, written by Research Associates Incorporated in 1968 and updated by DTNSRDC in 1978. REACT is written in FORTRAN IV and is a event storing simulation.

SOS[2] was written in 1980 by DTNSRDC and uses a scheduling algorithm to assign cargo to ships while maintaining a high ship volume utilization.

TEST RUNS

Several test runs were made using REACT, SOS, and SAILS considering the same scenario. The 4102 OPLAN (combined attack force and resupply, non-container) was the selected scenario. The results of these runs are described briefly. Table 4 gives the input parameters used and Table 5 gives the cargo delivery sums of these runs. Table 6 gives the number of ships selected by each model.

REACT

REACT was allowed to execute for 1 1/2 hours of CPU time. At its termination, no usable results were produced. For this reason further runs were not considered. Ships entered and exited ports without either picking up or delivering cargo. It was observed that having an excessive number of ships available is the only guarantee that the cargo delivery requirements can be met. No comparison could be made between SAILS and REACT.

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*A complete listing of references is given on page 57.

TABLE 4 - OPLAN 4102, INPUT PARAMETERS

Ports (LPRCS)*	Cargo Available (mts)
2CD	65134
2D	-
2H	83930
2K	63573
3G	325939
3H	2155
3J	14731912
3K	962095
3L	2707432
3M	7872
3N	332275
3P	1502593
3R	806510
3S	104492
3T	325174
5HD	-
5ND	187272
5F	-
7FB	-
4S	-
4KA	-
2VA	-
4K	137327
3LA	-
4L	-
4GA	-
4P	-

* Logistics Planning and Reporting Codes

TABLE 4 (Continued)

Ports (LPRCS)	Cargo Available (mts)
4Q	-
4FB	-
4N	10305
2F	-
4AA	-
4B	-
2CB	-
4KN	-
4AC	-

TABLE 5 - OPLAN 4102, ACCUMULATIVE CARGO DELIVERY

Simulation Time (Days)	SOS Delivered (mt)	SAILS Delivered (mt)	SAILS Delivered* (mt)
20	144133	60654	60580
30	1091759	853790	842195
40	2283473	2658337	482195
50	3935373	5013771	4845484
60	5994317	6038107	6108519
70	7204902	7232791	6883084
80	8075415	8310099	7985172
90	8597770	8879050	8725626
100	8856058	9045052	9057364

* Ships initialized from the ship pool

TABLE 6 - OPLAN 4102, SHIPS USED

Ship Type	Ships Available	SOS Ships Used	SAILS Ships Used	SAILS-Pool Ships Used
BBS	419	413	416	419
BBF	149	149	149	149
ROROS	5	5	5	5
ROROF	6	6	0	0
COMBS	4	4	4	4
COMBF	8	8	8	8
LASH	15	15	15	15
STRHV	9	9	9	9
STRNSS	1	1	1	0
SEABEE	3	3	3	2

SOS

SOS gave the best results, that is, the greatest amount of cargo was delivered by the fewest ships within a given time interval. This model determines cargo delivery requirements by building an itinerary for each ship used. Ships are treated individually and assigned cargo by a ship type preference determined by the user. In this manner the most productive ships may be utilized first. Since SOS has a minimum ship utilization requirement, ships are used efficiently. Each ship's itinerary or schedule is completed for the entire simulation before the next ship is considered. No interaction between ships is allowed. Of all the ships considered by the model, only those needed to move cargo were used.

This model assumes that all berthside facilities necessary to service arriving ships are available. Heavy port traffic is simulated by increasing the ship's service time by a delay time computed from an average berth queue time and the probability that the ship will wait.

CONCLUSIONS

Although REACT is the oldest model and has received the most use, its application is limited. REACT seems best suited for scenarios with limited

cargo aggregation and ship requirements. This simulation is not recommended for large cases since execution of these cases would be time-consuming and very costly.

SOS is recommended when ship operations are most important. On the other hand, SAILS gives a better profile of port operations. Table 7 shows the similarities and differences of REACT, SOS, and SAILS.

TABLE 7 - LOGIC DIFFERENCES OF REACT, SOS, AND SAILS

Model	Cargo Identity	Ships	Berth Queues	Ship Pool	Convoys
REACT	Lost	Interactive	Yes	Yes	Yes
SOS	Saved	Independent	No	Yes	No
SAILS	Saved	Interactive	Yes	Yes	Yes

Ship Selection Preference	Cargo Generation entries	Ships Utilization Req	Cargo RDD Checked	Cargo Type Priority Selection Preference
No	Yes	Yes	No	Yes
Yes	No	Yes	Yes	Yes
Yes	Yes	Yes	Yes	No

APPENDIX A

SAMPLE RUN

SAILS - SHIPPING ANALYSIS AND INTEGRATED LOGISTICS SIMULATION

RUN ID - TEST CASE UE+PESUPPLY
INPUT

NUMBER OF THEATERS = 38
SIMULATION END TIME = 120.
STATUS SUMMARY INTERVAL = 30.
TIME FOR SHIPS TO ENTER POOL = 1

PORT NO	PORT NAME	THEA NO	FACILITY BY TYPE 1	2	3	4	5	6	TRANSIT DELAY	PORT ADJ FACTOR
1	2CO	1	99	99	99	99	99	99	1.50	1.00
2	2D	2	99	99	99	99	99	99	1.50	1.00
3	2H	3	99	99	99	99	99	99	1.50	1.00
4	2K	4	99	99	99	99	99	99	1.50	1.00
5	3G	5	99	99	99	99	99	99	1.50	1.00
6	3H	6	99	99	99	99	99	99	1.50	1.00
7	3J	7	99	99	99	99	99	99	1.50	1.00
8	3K	8	99	99	99	99	99	99	1.50	1.00
9	3L	9	99	99	99	99	99	99	1.50	1.00
10	3M	10	99	99	99	99	99	99	1.50	1.00
11	3N	11	99	99	99	99	99	99	1.50	1.00
12	3P	12	99	99	99	99	99	99	1.50	1.00
13	3R	13	99	99	99	99	99	99	1.50	1.00
14	3S	14	99	99	99	99	99	99	1.50	1.00
15	3T	15	99	99	99	99	99	99	1.50	1.00
16	5HO	16	99	99	99	99	99	99	1.50	1.00
17	5NO	17	99	99	99	99	99	99	1.50	1.00
18	5G	18	99	99	99	99	99	99	1.50	1.00
19	7FB	19	99	99	99	99	99	99	1.50	1.00
20	4S	20	99	99	99	99	99	99	1.50	1.00
21	4KA	21	99	99	99	99	99	99	1.50	1.00
22	2VA	22	99	99	99	99	99	99	1.50	1.00
23	4K	23	99	99	99	99	99	99	1.50	1.00
24	3LA	24	99	99	99	99	99	99	1.50	1.00
25	4L	25	99	99	99	99	99	99	1.50	1.00
26	4GA	26	99	99	99	99	99	99	1.50	1.00
27	4P	27	99	99	99	99	99	99	1.50	1.00
28	4Q	28	99	99	99	99	99	99	1.50	1.00
29	4FB	29	99	99	99	99	99	99	1.50	1.00
30	4ED	30	99	99	99	99	99	99	1.50	1.00
31	4N	31	99	99	99	99	99	99	1.50	1.00
32	2F	32	99	99	99	99	99	99	1.50	1.00
33	4AA	33	99	99	99	99	99	99	1.50	1.00
34	4B	34	99	99	99	99	99	99	1.50	1.00
35	2CE	35	99	99	99	99	99	99	1.50	1.00
36	4KB	36	99	99	99	99	99	99	1.50	1.00
37	4AC	37	99	99	99	99	99	99	1.50	1.00
38	DUM	38	99	99	99	99	99	99	1.50	1.00

NUMBER OF SHIPS CONSIDERED = 618
NUMBER OF PORTS CONSIDERED = 38

STATUS REPORT SUMMARY AT GAME TIME = 128.

GENERAL:

NUMBER OF SHIPS IN SERVICE = 13
NUMBER OF SHIPS IN THE POOL = 605
TOTAL MTS AVAILABLE = 9098050.
TOTAL MTS SHIPPED = 9065784.
TOTAL MTS DELIVERED = 9064125.

I. PORT SUMMARY.

PORT NO	PORT NAME	CARGO MTS GENERATED	CARGO MTS SHIPPED	CARGO MTS DELIVERED	SHIPS SERVICED	AVG DAYS SERVICED	SHIPS QUEUED	AVG DAYS QUEUED
1	2CD	65134	65134	0	3	8.09	0	0.00
3	2H	83930	83930	0	5	5.49	0	0.00
4	2K	63573	62913	0	4	11.25	0	0.00
5	3G	325939	324538	0	21	6.84	0	0.00
6	3H	2155	2067	0	0	0.00	0	0.00
7	3J	1473912	1469525	0	128	6.09	0	0.00
8	3K	962095	955658	0	75	5.28	0	0.00
9	3L	2707432	2700524	0	232	7.28	0	0.00
10	3M	7872	5128	0	0	0.00	0	0.00
11	3N	332275	323097	0	32	5.00	0	0.00
12	3P	1502593	1500527	0	134	4.46	0	0.00
13	3R	806510	804918	0	74	5.41	0	0.00
14	3S	104492	103112	0	10	4.71	0	0.00
15	3T	325174	323633	0	34	3.62	0	0.00
17	5ND	187272	187272	0	19	3.80	0	0.00
20	4S	0	0	198274	11	8.56	0	0.00
21	4KA	0	0	7774204	643	5.01	0	0.00
23	4K	0	0	5660	1	4.79	0	0.00
24	3LA	137327	135451	0	12	5.00	0	0.00
25	4L	0	0	756972	70	5.30	0	0.00
26	4GA	0	0	66671	6	3.57	0	0.00
27	4P	0	0	75314	7	4.59	0	0.00
28	4Q	0	0	46057	5	7.07	0	0.00
29	4FB	0	0	25738	4	2.89	0	0.00
30	4ED	0	0	25429	3	3.13	0	0.00
31	4N	10365	10365	39335	6	4.53	0	0.00
32	2F	0	0	122094	10	8.12	0	0.00
33	4AA	0	0	9033	1	3.31	0	0.00
34	4B	0	0	3793	0	0.00	0	0.00
36	4KB	0	0	5551	2	5.05	0	0.00
TOTAL		9098050.	9065784.	9064125.	1552	5.48	0	0.00

II SHIP SUMMARY.

SHIP NO	SHIP TYPE	HOME PORT	OWNR CODE	TIME AT SEA DAYS	TIME IN PORT DAYS	AVERAGE UTILIZATION	CARGO MTS MOVED
1	1	11	0	13.6	14.7	.500	10286
2	1	15	0	7.1	2.9	.500	10286
3	1	12	0	36.1	11.1	.375	20572
4	1	8	0	22.7	8.1	.333	17708
5	1	9	0	25.2	10.2	.375	20572
6	1	1	0	32.1	6.7	.357	19117
7	1	8	0	25.8	5.9	.375	20572
8	1	8	0	19.7	5.9	.375	20572
9	1	12	0	28.4	19.4	.326	16546
10	1	9	0	22.7	7.1	.213	14404
11	1	7	0	33.4	7.3	.375	20572
12	1	13	0	13.6	14.7	.500	10286
13	1	11	0	15.2	3.8	.500	10286
14	1	7	0	19.0	5.9	.375	20572
15	1	8	0	25.0	9.7	.375	20572
16	1	12	0	35.3	5.9	.375	20572
17	1	7	0	19.0	5.9	.375	20572
18	1	17	0	7.1	2.9	.500	10286
19	1	17	0	7.1	2.9	.500	10286
20	1	12	0	28.4	8.3	.326	13416
21	1	15	0	13.1	4.4	.500	10286
22	1	8	0	36.6	8.2	.375	20572
23	1	7	0	13.1	14.7	.500	10286
24	1	13	0	13.1	2.9	.500	10286
25	1	13	0	7.1	2.9	.500	10286
26	1	9	0	12.6	2.9	.500	10286
27	1	3	0	30.8	9.8	.158	12597
28	1	8	0	34.2	7.4	.263	15793
29	1	12	0	24.1	6.6	.206	11403
30	1	15	0	16.1	11.0	.388	10286
31	1	8	0	25.8	5.9	.375	20572
32	1	11	0	13.1	2.9	.500	10286
33	1	14	0	7.1	2.9	.500	10286
34	1	14	0	7.1	2.9	.500	10286
35	1	9	0	25.2	6.8	.337	18998
36	1	9	0	26.2	17.5	.374	20535
37	1	13	0	7.1	2.9	.500	10286
38	1	15	0	7.1	2.9	.500	10286
39	1	11	0	37.1	6.6	.362	19482
40	1	8	0	38.7	8.2	.288	11845
41	1	14	0	13.1	3.8	.500	10286
42	1	9	0	13.1	14.7	.500	10286
43	1	12	0	13.1	5.6	.500	10286
44	1	9	0	13.1	14.7	.500	10286
45	1	9	0	13.1	14.7	.500	10286
46	1	8	0	13.1	2.9	.500	10286
47	1	12	0	13.1	5.6	.500	10286
48	1	11	0	13.1	5.6	.500	10286
49	1	9	0	13.1	14.7	.500	10286
50	1	9	0	13.1	14.7	.500	10286
51	1	14	0	13.4	4.0	.164	3364
52	1	8	0	13.1	2.9	.500	10286
53	1	13	0	21.5	2.9	.500	10286
54	1	7	0	13.6	7.6	.500	10286

II SHIP SUMMARY.

SHIP NO	SHIP TYPE	HOME PORT	OWNR CODE	TIME AT SEA DAYS	TIME IN PORT DAYS	AVERAGE UTILIZATION	CARGO MTS MOVED
55	1	13	0	21.5	7.1	.500	10286
56	1	12	0	13.1	5.6	.500	10286
57	1	14	0	13.1	2.9	.500	10286
58	1	9	0	13.1	14.7	.500	10286
59	1	8	0	13.1	2.9	.500	10286
60	1	8	0	25.4	14.6	.349	20572
61	1	9	0	28.1	11.1	.375	20572
62	1	7	0	40.6	6.6	.375	20572
63	1	8	0	12.6	5.8	.500	10286
64	1	12	0	13.1	14.7	.500	10286
65	1	12	0	13.1	14.7	.500	10286
66	1	9	0	24.2	15.1	.328	16642
67	1	7	0	41.8	9.8	.322	16231
68	1	9	0	28.2	9.8	.318	17301
69	1	7	0	12.6	7.2	.500	10286
70	1	13	0	7.1	2.9	.500	10286
71	1	12	0	13.1	14.7	.500	10286
72	1	12	0	13.1	14.7	.500	10286
73	1	12	0	13.1	14.7	.500	10286
74	1	3	0	31.5	6.4	.198	11290
75	1	7	0	10.5	4.9	.327	10286
76	1	15	0	7.1	2.9	.500	10286
77	1	9	0	42.8	15.9	.335	22120
78	1	9	0	10.5	8.2	.278	10286
79	1	11	0	7.1	2.9	.500	10286
80	1	14	0	7.1	2.9	.500	10286
81	1	7	0	13.9	1.7	.500	10286
82	1	9	0	21.5	2.9	.500	10286
83	1	14	0	41.4	6.8	.278	11425
84	1	9	0	13.1	14.7	.500	10286
85	1	7	0	7.1	2.9	.500	10286
86	1	12	0	15.5	3.8	.581	10286
87	1	11	0	13.1	7.2	.500	10286
88	1	8	0	13.1	7.2	.500	10286
89	1	9	0	29.5	6.6	.381	13796
90	1	8	0	12.0	2.9	.500	10286
91	1	12	0	15.5	2.9	.500	10286
92	1	12	0	15.5	2.9	.500	10286
93	1	7	0	13.1	14.7	.500	10286
94	1	9	0	13.1	2.9	.500	10286
95	1	12	0	25.8	7.7	.374	20543
96	1	12	0	25.8	5.9	.375	20572
97	1	12	0	25.8	5.9	.375	20572
98	1	9	0	13.1	2.9	.500	10286
99	1	12	0	13.1	2.9	.500	10286
100	1	9	0	13.1	2.9	.500	10286
101	1	8	0	36.1	8.5	.375	20572
102	1	9	0	12.6	2.9	.500	10286
103	1	13	0	7.1	2.9	.500	10286
104	1	12	0	13.1	14.7	.500	10286
105	1	5	0	12.6	2.9	.500	10286
106	1	14	0	7.1	2.9	.500	10286
107	1	13	0	7.1	2.9	.500	10286
108	1	13	0	7.1	2.9	.500	10286
109	1	12	0	13.1	2.9	.500	10286

II SHIP SUMMARY.

SHIP NO	SHIP TYPE	HOME PORT	OWNR CODE	TIME AT SEA DAYS	TIME IN PORT DAYS	AVERAGE UTILIZATION	CARGO MTS MOVED
110	1	9	0	13.1	2.9	.500	10286
111	1	7	0	25.8	5.9	.375	20572
112	1	7	0	25.8	5.9	.375	20572
113	1	8	0	13.1	14.7	.500	10286
114	1	13	0	21.5	3.6	.500	10286
115	1	7	0	25.8	5.9	.375	20572
116	1	8	0	36.9	7.8	.197	13986
117	1	13	0	15.5	3.0	.500	10286
118	1	15	0	13.1	2.9	.500	10286
119	1	9	0	13.1	2.9	.500	10286
120	1	9	0	13.1	2.9	.500	10286
121	1	12	0	7.1	2.9	.500	10286
122	1	9	0	13.1	2.9	.500	10286
123	1	12	0	7.1	2.9	.500	10286
124	1	9	0	13.1	2.9	.500	10286
125	1	14	0	15.5	2.9	.500	10286
126	1	9	0	10.5	4.4	.258	10286
127	1	12	0	43.6	8.6	.254	10455
128	1	13	0	13.1	2.9	.500	10286
129	1	7	0	13.1	2.9	.500	10286
130	1	7	0	13.1	2.9	.500	10286
131	1	12	0	30.4	9.8	.269	11556
132	1	14	0	20.8	4.3	.854	1110
133	1	12	0	7.1	2.9	.500	10286
134	1	9	0	13.1	7.2	.500	10286
135	1	9	0	19.8	4.8	.167	3431
136	1	15	0	7.1	2.9	.500	10286
137	1	15	0	7.1	2.9	.500	10286
138	1	14	0	7.1	2.9	.500	10286
139	1	12	0	22.7	5.6	.500	10286
140	1	9	0	23.0	7.1	.398	10286
141	1	12	0	10.1	6.6	.318	6532
142	1	14	0	20.9	10.7	.280	11532
143	1	13	0	7.1	2.9	.500	10286
144	1	9	0	46.7	9.8	.407	20572
145	1	12	0	16.9	4.6	.285	5864
146	1	9	0	7.1	2.9	.500	10286
147	1	9	0	7.1	2.9	.500	10286
148	1	13	0	7.1	2.9	.500	10286
149	1	9	0	23.0	14.0	.369	10286
150	1	8	0	7.1	2.9	.500	10286
151	1	12	0	13.1	14.7	.500	10286
152	1	5	0	32.8	6.8	.228	11587
153	1	7	0	13.6	13.9	.500	10286
154	1	6	0	29.3	7.1	.351	18199
155	1	7	0	15.2	4.5	.500	10286
156	1	12	0	13.1	14.7	.500	10286
157	1	9	0	12.6	2.9	.508	10286
158	1	9	0	12.6	2.9	.500	10286
159	1	7	0	44.8	12.7	.401	27128
160	1	9	0	12.6	2.9	.500	10286
161	1	5	0	36.1	11.5	.375	20572
162	1	7	0	14.7	7.9	.368	10286
163	1	14	0	16.9	4.1	.360	7406
164	1	12	0	13.1	14.7	.500	10286

II SHIP SUMMARY.

SHIP NO	SHIP TYPE	HOME PORT	OWNR CODE	TIME AT SEA DAYS	TIME IN PORT DAYS	AVERAGE UTILIZATION	CARGO MTS. MOVED
165	1	12	0	13.1	14.7	.500	10286
166	1	15	0	13.1	2.9	.500	10286
167	1	15	0	13.1	3.0	.500	10286
168	1	11	0	13.1	14.7	.500	10286
169	1	9	0	12.6	2.9	.500	10286
170	1	9	0	12.6	2.9	.500	10286
171	1	6	0	36.1	5.9	.375	20572
172	1	11	0	13.1	14.7	.500	10286
173	1	12	0	13.1	14.7	.500	10286
174	1	9	0	12.6	7.2	.500	10286
175	1	9	0	33.6	8.4	.174	8890
176	1	12	0	13.1	18.4	.500	10286
177	1	7	0	19.0	7.3	.375	20572
178	1	11	0	14.2	5.7	.259	5325
179	1	9	0	19.7	5.9	.375	20572
180	1	11	0	27.3	12.0	.321	20572
181	1	8	0	19.7	5.9	.375	20572
182	1	13	0	7.1	2.9	.500	10286
183	1	7	0	39.6	9.7	.375	20572
184	1	9	0	19.1	10.2	.375	20572
185	1	8	0	25.8	18.3	.375	20572
186	1	9	0	19.1	9.4	.343	19250
187	1	7	0	36.1	7.8	.375	20572
188	1	8	0	25.8	8.2	.375	20572
189	1	13	0	7.1	5.7	.500	10286
190	1	8	0	26.8	9.7	.310	17072
191	1	17	0	31.1	6.2	.265	10905
192	1	1	0	39.6	5.9	.375	20572
193	1	8	0	25.8	5.7	.347	19412
194	1	5	0	38.2	9.8	.285	20788
195	1	8	0	13.1	2.9	.500	10286
196	1	9	0	13.1	2.9	.500	10286
197	1	7	0	13.1	2.9	.500	10286
198	1	9	0	13.1	2.9	.500	10286
199	1	11	0	7.1	2.9	.500	10286
200	1	12	0	7.1	2.9	.500	10286
201	1	5	0	36.6	5.9	.375	20572
202	1	6	0	13.1	2.9	.500	10286
203	1	7	0	36.9	7.0	.350	18163
204	1	9	0	13.1	2.9	.500	10286
205	1	9	0	13.1	2.9	.500	10286
206	1	12	0	7.1	2.9	.500	10286
207	1	9	0	13.1	2.9	.500	10286
208	1	12	0	7.1	2.9	.500	10286
209	1	9	0	13.1	5.6	.500	10286
210	1	9	0	13.1	5.1	.500	10286
211	1	7	0	13.1	2.9	.500	10286
212	1	9	0	13.1	6.8	.500	10286
213	1	11	0	7.1	2.9	.500	10286
214	1	12	0	7.1	2.9	.500	10286
215	1	12	0	13.1	6.7	.500	10286
216	1	7	0	15.9	14.7	.500	10286
217	1	15	0	13.1	2.9	.500	10286
218	1	9	0	13.1	4.5	.500	10286
219	1	7	0	13.1	2.9	.500	10286

II SHIP SUMMARY.

SHIP NO	SHIP TYPE	HOME PORT	OWNR CODE	TIME AT SEA DAYS	TIME IN PORT DAYS	AVERAGE UTILIZATION	CARGO MTS MOVED
220	1	17	0	13.1	2.9	.500	10286
221	1	8	0	13.1	2.9	.500	10286
222	1	9	0	13.1	2.9	.500	10286
223	1	12	0	12.6	14.7	.500	10286
224	1	7	0	36.1	5.9	.375	20572
225	1	7	0	36.1	6.1	.375	20572
226	1	12	0	13.1	2.9	.500	10286
227	1	15	0	15.5	2.9	.500	10286
228	1	7	0	36.1	5.9	.375	20572
229	1	9	0	26.8	7.4	.112	11634
230	1	4	0	13.1	2.9	.500	10286
231	1	12	0	12.6	14.7	.500	10286
232	1	5	0	15.5	2.9	.500	10286
233	1	8	0	12.1	2.9	.500	10286
234	1	11	0	7.1	2.9	.500	10286
235	1	7	0	7.1	6.5	.500	10286
236	1	11	0	7.1	4.3	.500	10286
237	1	7	0	7.1	4.3	.500	10286
238	1	12	0	13.1	2.9	.500	10286
239	1	9	0	34.1	10.2	.375	20572
240	1	9	0	7.1	2.9	.500	10286
241	1	6	0	28.6	7.3	.500	20572
242	1	5	0	7.1	2.9	.500	10286
243	1	7	0	7.1	4.3	.500	10286
244	1	7	0	7.1	4.3	.500	10286
245	1	13	0	15.5	2.9	.500	10286
246	1	8	0	15.5	2.9	.500	10286
247	1	8	0	31.0	7.2	.499	20527
248	1	8	0	15.5	7.2	.500	10286
249	1	5	0	7.1	2.9	.500	10286
250	1	5	0	28.6	5.9	.500	20572
251	1	12	0	19.3	3.5	.276	2839
252	1	13	0	15.5	6.1	.500	10286
253	1	8	0	15.5	3.1	.500	10286
254	1	12	0	41.0	7.8	.287	11798
255	1	9	0	20.8	7.9	.261	10286
256	1	14	0	22.6	3.5	.096	987
257	1	12	0	22.7	5.6	.500	10286
258	1	8	0	14.5	4.6	.422	8675
259	1	9	0	39.4	19.5	.411	20572
260	1	11	0	21.5	13.6	.500	10286
261	1	9	0	23.5	7.3	.267	10286
262	1	9	0	50.0	10.5	.334	20572
263	1	9	0	23.2	7.8	.222	10286
264	1	5	0	28.6	5.9	.500	20572
265	1	7	0	7.1	4.2	.500	10286
266	1	9	0	46.4	10.6	.345	20572
267	1	12	0	22.7	3.1	.500	10286
268	1	12	0	29.8	7.3	.500	20572
269	1	15	0	22.7	4.4	.500	10286
270	1	11	0	21.5	2.9	.500	10286
271	1	15	0	21.5	2.9	.500	10286
272	1	14	0	19.6	3.4	.076	780
273	1	12	0	7.1	7.2	.500	10286
274	1	12	0	7.1	6.2	.500	10286

II SHIP SUMMARY.

SHIP NO	SHIP TYPE	HOME PORT	OWNR CODE	TIME AT SEA DAYS	TIME IN PORT DAYS	AVERAGE UTILIZATION	CARGO MTS MOVED
275	1	9	0	11.9	5.4	.474	9750
276	1	13	0	18.5	5.8	.432	10286
277	1	9	0	18.0	5.2	.400	8219
278	1	8	0	15.5	2.9	.530	10286
279	1	11	0	21.5	2.9	.500	10286
280	1	9	0	31.5	10.7	.146	10823
281	1	13	0	23.5	2.9	.500	10286
282	1	9	0	43.0	6.7	.369	15991
283	1	8	0	14.5	2.9	.500	10286
284	1	9	0	18.5	6.4	.297	6103
285	1	9	0	17.3	5.9	.254	5227
286	1	9	0	40.9	6.8	.326	13416
287	1	15	0	22.7	2.9	.500	10286
288	1	9	0	45.0	6.8	.326	13416
289	1	12	0	22.7	5.6	.500	10286
290	1	9	0	19.8	4.4	.122	2514
291	1	9	0	7.1	5.0	.500	10286
292	1	8	0	28.6	7.3	.500	20572
293	1	8	0	28.6	9.8	.500	20572
294	1	7	0	7.1	1.9	.500	10286
295	1	9	0	38.0	13.0	.343	20572
296	1	17	0	22.7	2.9	.500	10286
297	1	9	0	28.6	10.2	.500	20572
298	1	5	0	21.5	2.9	.500	10286
299	1	9	0	28.6	10.2	.500	20572
300	1	9	0	29.8	5.9	.500	20572
301	1	8	0	7.1	7.2	.500	10286
302	1	12	0	7.1	6.9	.500	10286
303	1	12	0	7.1	5.6	.500	10286
304	1	7	0	13.9	1.7	.500	10286
305	1	9	0	28.6	10.2	.500	20572
306	1	8	0	7.1	5.6	.500	10286
307	1	9	0	29.8	5.9	.500	20572
308	1	12	0	7.1	5.6	.500	10286
309	1	7	0	17.0	3.2	.361	7417
310	1	9	0	28.6	10.2	.500	20572
311	1	8	0	7.1	5.6	.500	10286
312	1	7	0	13.9	1.6	.500	10286
313	1	8	0	7.1	5.6	.500	10286
314	1	7	0	17.0	3.1	.263	5404
315	1	9	0	29.8	5.9	.500	20572
316	1	13	0	27.0	2.9	.500	10286
317	1	9	0	28.6	10.3	.500	20572
318	1	7	0	21.0	3.5	.084	864
319	1	9	0	23.5	2.9	.500	10286
320	1	8	0	27.0	2.9	.500	10286
321	1	12	0	7.1	2.7	.423	8695
322	1	13	0	21.5	2.9	.500	10286
323	1	14	0	22.7	2.9	.500	10286
324	1	7	0	21.0	4.1	.383	7882
325	1	9	0	26.3	3.7	.235	2416
326	1	9	0	23.5	2.9	.500	10286
327	1	12	0	7.1	7.2	.500	10286
328	1	12	0	10.1	4.9	.168	3455
329	1	8	0	27.0	3.5	.500	10286

II SHIP SUMMARY.

SHIP NO	SHIP TYPE	HOME PORT	OWNR CODE	TIME AT SEA DAYS	TIME IN PORT DAYS	AVERAGE UTILIZATION	CARGO MTS MOVED
330	1	12	0	27.1	3.8	.032	330
331	1	8	0	27.0	6.2	.500	10286
332	1	17	0	18.5	3.9	.160	1645
333	1	7	0	23.5	2.9	.500	10286
334	1	15	0	13.1	3.8	.500	10286
335	1	8	0	27.0	5.8	.500	10286
336	1	15	0	13.1	5.6	.500	10286
337	1	7	0	37.1	6.1	.255	10502
338	1	13	0	21.5	2.9	.500	10286
339	1	14	0	22.7	2.9	.500	10286
340	1	9	0	23.5	2.9	.500	10286
341	1	7	0	18.9	3.9	.637	6556
342	1	15	0	13.1	5.4	.500	10286
343	1	15	0	13.1	2.9	.500	10286
344	1	5	0	27.0	2.9	.500	10286
345	1	13	0	16.1	6.2	.368	7567
346	1	12	0	22.7	7.2	.500	10286
347	1	5	0	22.7	3.3	.500	10286
348	1	9	0	26.3	3.3	.221	2278
349	1	17	0	18.5	3.2	.160	1642
350	1	9	0	23.5	2.9	.500	10286
351	1	9	0	23.5	2.9	.500	10286
352	1	15	0	13.1	2.9	.500	10286
353	1	1	0	21.5	7.2	.500	10286
354	1	8	0	22.7	2.9	.500	10286
355	1	17	0	21.5	7.2	.500	10286
356	1	4	0	12.6	3.2	.500	10286
357	1	9	0	23.5	5.2	.500	10286
358	1	7	0	22.7	3.0	.500	10286
359	1	12	0	22.7	6.3	.416	8566
360	1	17	0	22.7	2.9	.500	10286
361	1	9	0	22.7	5.2	.500	10286
362	1	9	0	22.7	2.9	.500	10286
363	1	12	0	21.5	7.2	.500	10286
364	1	9	0	22.7	5.0	.500	10286
365	1	11	0	7.1	2.9	.500	10286
366	1	5	0	25.7	3.9	.634	6526
367	1	9	0	12.6	3.2	.500	10286
368	1	7	0	22.7	3.4	.500	10286
369	1	12	0	21.5	7.1	.488	10035
370	1	9	0	12.6	5.6	.500	10286
371	1	9	0	12.6	5.0	.500	10286
372	1	9	0	12.6	2.9	.500	10286
373	1	15	0	13.1	2.9	.500	10286
374	1	9	0	12.6	2.9	.500	10286
375	1	9	0	37.6	10.9	.322	16815
376	1	9	0	18.5	4.1	.376	7740
377	1	7	0	36.1	5.9	.375	20572
378	1	9	0	13.1	14.7	.500	10286
379	1	7	0	7.1	3.1	.500	10286
380	1	13	0	13.1	2.9	.500	10286
381	1	12	0	7.1	4.3	.500	10286
382	1	15	0	21.5	9.5	.500	10286
383	1	12	0	18.2	4.3	.235	4829
384	1	12	0	19.7	10.2	.375	20572

II SHIP SUMMARY.

SHIP NO	SHIP TYPE	HOME PORT	OWNR CODE	TIME AT SEA DAYS	TIME IN PORT DAYS	AVERAGE UTILIZATION	CARGO MTS MOVED
385	1	7	0	25.2	5.9	.375	20572
386	1	9	0	27.2	19.1	.281	12810
387	1	14	0	22.7	4.8	.474	9746
388	1	14	0	13.1	7.2	.500	10286
389	1	15	0	7.1	2.9	.500	10286
390	1	15	0	7.1	2.9	.500	10286
391	1	5	0	30.4	7.4	.257	15610
392	1	8	0	20.2	7.7	.344	10286
393	1	8	0	15.6	9.3	.240	4947
394	1	12	0	13.1	2.9	.500	10286
395	1	8	0	12.6	2.9	.500	10286
396	1	9	0	36.1	5.9	.375	20572
397	1	12	0	13.1	2.9	.500	10286
398	1	5	0	37.9	8.1	.350	18505
399	1	9	0	13.1	14.7	.500	10286
400	1	12	0	13.1	2.9	.500	10286
401	1	4	0	17.5	5.4	.336	10286
402	1	9	0	12.6	2.9	.500	10286
403	1	7	0	12.6	14.7	.500	10286
404	1	12	0	13.1	2.9	.500	10286
405	1	9	0	13.1	2.9	.500	10286
406	1	12	0	13.1	2.9	.500	10286
407	1	9	0	12.0	14.2	.500	10286
408	1	5	0	36.1	5.9	.375	20572
409	1	8	0	34.1	10.2	.375	20572
410	1	8	0	29.0	7.6	.188	11156
411	1	3	0	32.7	13.5	.313	20572
412	1	7	0	44.2	9.8	.314	17189
413	1	8	0	12.6	7.2	.500	10286
414	1	12	0	15.9	10.5	.283	5828
415	1	9	0	34.1	10.2	.375	20572
416	1	15	0	21.5	14.7	.500	10286
417	1	9	0	35.3	5.9	.375	20572
418	1	9	0	34.1	10.2	.375	20572
419	1	15	0	21.5	14.7	.500	10286
420	2	8	0	33.7	23.8	.358	22877
421	2	12	0	33.4	14.6	.290	31510
422	2	9	0	29.1	20.7	.093	12669
423	2	8	0	25.4	19.0	.233	17053
424	2	9	0	29.1	17.7	.291	23458
425	2	11	0	42.6	20.3	.258	23729
426	2	13	0	14.7	7.7	.296	6938
427	2	9	0	17.3	6.3	.375	23458
428	2	8	0	21.2	9.3	.375	23458
429	2	9	0	17.3	8.8	.375	23458
430	2	9	0	17.3	6.3	.375	23458
431	2	7	0	20.7	22.8	.326	19984
432	2	7	0	30.0	9.5	.358	22652
433	2	8	0	21.2	8.8	.375	23458
434	2	9	0	17.3	6.3	.375	23458
435	2	15	0	31.0	6.2	.260	12193
436	2	12	0	32.4	11.0	.382	29734
437	2	17	0	10.9	3.2	.500	11729
438	2	12	0	28.6	12.6	.344	35187
439	2	8	0	30.0	6.3	.375	23458

II SHIP SUMMARY.

SHIP NO	SHIP TYPE	HOME PORT	OWNR CODE	TIME AT SEA DAYS	TIME IN PORT DAYS	AVERAGE UTILIZATION	CARGO MTS MOVED
440	2	8	0	30.0	6.3	.375	23458
441	2	15	0	6.4	3.6	.500	11729
442	2	15	0	18.7	3.7	.899	1164
443	2	14	0	28.7	9.0	.277	12985
444	2	7	0	10.9	15.8	.500	11729
445	2	9	0	33.4	10.6	.079	13580
446	2	8	0	20.7	9.0	.142	14214
447	2	9	0	23.7	8.5	.375	23458
448	2	7	0	19.9	8.7	.340	15096
449	2	9	0	11.3	16.5	.500	11729
450	2	9	0	24.4	7.5	.361	21051
451	2	17	0	28.6	10.7	.133	7372
452	2	3	0	11.3	16.5	.500	11729
453	2	8	0	29.1	11.2	.375	23458
454	2	12	0	25.8	14.0	.291	14327
455	2	12	0	24.6	19.8	.375	23458
456	2	12	0	11.3	16.5	.500	11729
457	2	8	0	10.9	16.5	.500	11729
458	2	11	0	11.3	16.5	.500	11729
459	2	17	0	11.3	16.5	.500	11729
460	2	12	0	31.1	6.8	.329	21295
461	2	12	0	22.2	9.2	.375	23458
462	2	9	0	31.7	9.8	.114	14150
463	2	3	0	11.3	9.9	.500	11729
464	2	9	0	11.3	7.8	.500	11729
465	2	7	0	22.2	9.3	.375	23458
466	2	12	0	12.1	10.1	.243	5700
467	2	11	0	11.3	8.0	.500	11729
468	2	11	0	10.4	5.5	.438	10263
469	2	8	0	22.2	6.3	.375	23458
470	2	9	0	22.7	16.3	.375	23458
471	2	13	0	11.3	8.0	.508	11729
472	2	5	0	11.3	10.9	.508	11729
473	2	7	0	27.3	9.3	.251	17628
474	2	7	0	22.2	6.3	.375	23458
475	2	3	0	17.3	19.7	.375	23458
476	2	7	0	10.9	10.3	.500	11729
477	2	12	0	11.3	16.5	.500	11729
478	2	9	0	33.1	12.6	.263	12919
479	2	9	0	33.5	13.7	.265	14973
480	2	9	0	24.3	11.4	.271	12727
481	2	12	0	11.3	16.1	.500	11729
482	2	7	0	10.9	16.5	.500	11729
483	2	9	0	20.5	6.4	.293	13746
484	2	9	0	44.8	11.7	.227	10185
485	2	15	0	32.8	22.0	.326	23458
486	2	9	0	21.8	10.6	.375	23458
487	2	12	0	22.7	22.4	.375	23458
488	2	8	0	30.0	6.3	.375	23458
489	2	9	0	25.0	10.8	.332	20165
490	2	3	0	11.3	13.6	.500	11729
491	2	12	0	22.7	19.7	.375	23458
492	2	4	0	11.3	16.3	.500	11729
493	2	12	0	22.7	19.7	.375	23458
494	2	13	0	10.3	3.1	.500	11729

II SHIP SUMMARY.

SHIP NO	SHIP TYPE	HOME PORT	OWNR CODE	TIME AT SEA DAYS	TIME IN PORT DAYS	AVERAGE UTILIZATION	CARGO MTS MOVED
495	2	17	0	18.8	24.6	.301	11729
496	2	15	0	11.3	16.5	.500	11729
497	2	7	0	11.3	16.5	.500	11729
498	2	15	0	11.3	3.2	.500	11729
499	2	5	0	16.2	6.3	.375	23458
500	2	8	0	26.7	7.8	.251	17628
501	2	4	0	29.6	16.4	.360	23458
502	2	8	0	10.9	16.5	.500	11729
503	2	9	0	22.8	11.2	.375	23458
504	2	8	0	28.7	6.4	.299	14808
505	2	13	0	17.7	9.8	.312	10842
506	2	12	0	6.4	3.1	.500	11729
507	2	12	0	24.1	6.4	.267	13954
508	2	9	0	12.2	15.8	.500	11729
509	2	11	0	26.4	10.5	.330	21874
510	2	9	0	6.4	6.2	.500	11729
511	2	12	0	19.1	3.1	.500	11729
512	2	5	0	18.2	8.0	.500	11729
513	2	12	0	19.1	8.2	.500	11729
514	2	12	0	19.1	5.4	.500	11729
515	2	7	0	33.7	12.9	.251	17622
516	2	7	0	20.3	10.2	.200	16825
517	2	9	0	23.3	13.0	.181	15936
518	2	12	0	19.6	9.2	.263	12351
519	2	8	0	19.6	7.1	.287	13481
520	2	7	0	26.3	16.8	.291	18866
521	2	9	0	17.3	6.3	.375	23458
522	2	9	0	11.3	3.1	.500	11729
523	2	9	0	21.1	12.2	.267	18125
524	2	12	0	11.3	14.9	.500	11729
525	2	7	0	21.8	7.8	.375	23458
526	2	7	0	41.3	14.2	.283	19264
527	2	8	0	28.2	10.2	.344	35187
528	2	9	0	21.2	6.3	.375	23458
529	2	12	0	24.2	12.5	.334	21513
530	2	8	0	21.2	6.3	.375	23458
531	2	9	0	24.6	19.0	.319	14972
532	2	8	0	40.2	12.1	.208	28510
533	2	9	0	20.7	13.6	.401	11729
534	2	9	0	21.2	6.3	.375	23458
535	2	17	0	23.5	6.7	.271	12715
536	2	8	0	21.2	6.3	.375	23458
537	2	7	0	25.4	9.2	.175	15963
538	2	12	0	11.3	16.5	.500	11729
539	2	9	0	10.9	3.1	.500	11729
540	2	17	0	11.3	3.1	.500	11729
541	2	13	0	6.4	3.1	.500	11729
542	2	9	0	34.9	7.2	.182	15456
543	2	12	0	22.7	19.7	.375	23458
544	2	9	0	22.7	13.4	.327	21201
545	2	4	0	6.4	3.1	.500	11729
546	2	12	0	11.3	3.1	.500	11729
547	2	8	0	11.3	3.1	.500	11729
548	2	8	0	11.3	1.7	.500	11729
549	2	14	0	28.7	6.3	.252	11837

II SHIP SUMMARY.

SHIP NO	SHIP TYPE	HOME PORT	OWNR CODE	TIME AT SEA DAYS	TIME IN PORT DAYS	AVERAGE UTILIZATION	CARGO MTS MOVED
550	2	9	0	22.4	6.6	.285	13378
551	2	9	0	21.5	22.7	.375	23458
552	2	8	0	29.1	11.2	.375	23458
553	2	9	0	11.3	3.1	.500	11729
554	2	11	0	11.3	3.1	.500	11729
555	2	15	0	11.3	16.5	.500	11729
556	2	7	0	11.3	3.1	.500	11729
557	2	9	0	22.7	19.7	.375	23458
558	2	8	0	30.0	8.6	.375	23458
559	2	12	0	17.3	5.2	.375	23458
560	2	8	0	30.5	15.6	.278	18483
561	2	12	0	30.0	6.6	.375	23458
562	2	14	0	16.5	4.6	.268	11729
563	2	5	0	29.2	11.3	.330	17680
564	2	12	0	30.0	6.3	.375	23458
565	2	12	0	30.0	6.3	.375	23458
566	2	9	0	24.8	10.1	.370	23458
567	2	13	0	11.3	3.1	.500	11729
568	2	12	0	11.3	3.1	.500	11729
569	3	7	0	11.7	14.0	.500	11803
570	3	8	0	55.6	8.7	.899	40877
571	3	8	0	50.3	23.0	.402	29240
572	3	9	0	45.8	9.2	.875	39315
573	3	9	0	56.9	8.9	.923	42352
580	9	9	0	24.8	7.7	.375	33442
581	9	8	0	12.9	3.8	.500	16721
582	9	9	0	25.3	7.7	.375	33442
583	9	11	0	22.9	9.2	.285	26660
584	10	13	0	23.6	13.3	.148	28653
585	10	12	0	18.8	13.5	.254	23666
586	10	15	0	23.4	8.8	.183	30792
587	10	7	0	27.4	12.7	.142	48127
588	10	12	0	23.2	15.8	.119	26848
589	10	9	0	20.1	18.4	.114	26493
590	10	8	0	33.1	16.5	.291	47820
591	10	12	0	33.6	21.4	.241	39237
592	11	9	0	22.7	7.5	.267	31998
593	11	11	0	24.6	5.5	.306	32132
594	11	8	0	23.8	5.4	.536	41298
595	11	9	0	34.6	9.8	.140	12400
596	11	8	0	45.3	17.8	.222	56970
597	11	13	0	23.6	6.3	.298	43678
598	11	9	0	48.7	13.7	.322	47854
599	11	7	0	40.6	11.8	.869	61727
600	11	9	0	48.3	13.8	.549	65044
601	11	12	0	38.8	13.8	.417	73217
602	11	12	0	42.4	12.6	.089	58922
603	11	5	0	36.1	9.4	.152	60479
604	11	7	0	46.9	11.8	.434	50821
605	11	9	0	43.8	14.2	.172	36548
606	11	7	0	44.5	15.2	.674	77768
607	12	12	0	19.1	6.2	.266	8695
608	12	8	0	18.1	6.9	.256	15814
609	12	12	0	6.7	3.3	.500	12786
610	12	12	0	13.6	17.9	.508	12786

II SHIP SUMMARY.

SHIP NO	SHIP TYPE	HOME PORT	OWNR CODE	TIME AT SEA DAYS	TIME IN PORT DAYS	AVERAGE UTILIZATION	CARGO MTS MOVED
611	12	9	0	27.8	6.8	.185	13817
612	12	9	0	26.2	6.6	.375	25572
613	12	7	0	13.1	17.8	.500	12786
614	12	12	0	13.6	17.9	.500	12786
615	12	14	0	7.3	3.3	.500	12786
617	14	15	0	11.6	6.8	.500	31800
618	14	12	0	26.2	38.8	.224	31601
TOTAL	611	(SHIPS)		12346.6	4697.8	.416	9065784

III. CARGO MOVEMENT SUMMARY.

PORT POE	CARGO MTS BY RDD	CARGO MTS BY RDD+5	CARGO MTS REMAINING
20	0	0	188274
21	0	0	7774284
23	0	0	5660
25	0	0	756972
26	0	0	66671
27	0	0	75314
28	0	0	46057
29	0	0	25738
30	0	0	25429
31	0	0	39335
32	0	0	122094
33	0	0	9833
34	0	0	3793
36	0	0	5551
TOTAL	0	0	9064125

IV. UNMOVERED CARGO SUMMARY.

	POE	POD	TYPE	EAT	GDD	RDD	QUANTITY
1	4	25	7	52.	0.	0.	660
2	5	21	3	49.	0.	0.	291
3	5	21	2	42.	0.	0.	993
4	5	23	1	4.	0.	0.	117
5	6	21	1	26.	0.	0.	66
6	7	31	7	70.	0.	0.	13
7	7	31	6	70.	0.	0.	49
8	7	25	6	70.	0.	0.	40
9	7	28	1	70.	0.	0.	44
10	7	25	1	65.	0.	0.	544
11	7	33	7	60.	0.	0.	88
12	7	31	7	60.	0.	0.	266
13	7	31	1	60.	0.	0.	113
14	7	28	1	60.	0.	0.	58
15	7	27	1	60.	0.	0.	103
16	7	38	6	50.	0.	0.	171
17	7	38	1	50.	0.	0.	11
18	7	33	7	50.	0.	0.	66
19	7	31	1	50.	0.	0.	259
20	7	30	7	50.	0.	0.	24
21	7	30	6	50.	0.	0.	38
22	7	28	6	50.	0.	0.	110
23	7	28	1	50.	0.	0.	88
24	7	27	6	50.	0.	0.	28
25	7	27	1	50.	0.	0.	185
26	7	25	1	50.	0.	0.	24
27	7	33	7	40.	0.	0.	86
28	7	28	1	40.	0.	0.	58
29	7	27	1	40.	0.	0.	103
30	7	38	6	30.	0.	0.	171
31	7	38	1	30.	0.	0.	11
32	7	33	7	30.	0.	0.	140
33	7	30	6	30.	0.	0.	38
34	7	28	6	30.	0.	0.	110
35	7	28	1	30.	0.	0.	88
36	7	27	6	30.	0.	0.	28
37	7	27	1	30.	0.	0.	182
38	7	27	6	27.	0.	0.	23
39	7	33	7	20.	0.	0.	135
40	7	28	1	20.	0.	0.	58
41	7	27	1	20.	0.	0.	99
42	7	27	6	17.	0.	0.	20
43	7	38	6	10.	0.	0.	185
44	7	36	1	10.	0.	0.	14
45	7	33	7	10.	0.	0.	202
46	7	23	3	10.	0.	0.	37
47	7	29	1	6.	0.	0.	17
48	7	33	7	5.	0.	0.	27
49	7	26	1	4.	0.	0.	191
50	7	33	7	0.	0.	0.	22
51	8	32	1	70.	0.	0.	255
52	8	31	7	70.	0.	0.	82
53	8	31	1	70.	0.	0.	58
54	8	27	1	70.	0.	0.	41

IV. UNMOVERED CARGO SUMMARY.

	POE	POD	TYPE	EAT	EDD	RDD	QUANTITY
55	8	25	1	70.	0.	0.	10
56	8	20	6	70.	0.	0.	63
57	8	20	3	70.	0.	0.	19
58	8	20	1	70.	0.	0.	334
59	8	25	3	65.	0.	0.	213
60	8	25	1	65.	0.	0.	274
61	8	31	7	60.	0.	0.	235
62	8	31	3	60.	0.	0.	44
63	8	31	1	60.	0.	0.	56
64	8	29	3	60.	0.	0.	42
65	8	29	1	60.	0.	0.	54
66	8	28	3	60.	0.	0.	22
67	8	28	1	60.	0.	0.	30
68	8	27	3	60.	0.	0.	38
69	8	27	1	60.	0.	0.	53
70	8	25	1	55.	0.	0.	274
71	8	38	6	50.	0.	0.	18
72	8	38	1	50.	0.	0.	82
73	8	31	3	50.	0.	0.	154
74	8	30	7	50.	0.	0.	135
75	8	30	3	50.	0.	0.	11
76	8	30	1	50.	0.	0.	86
77	8	29	3	50.	0.	0.	42
78	8	29	1	50.	0.	0.	54
79	8	28	6	50.	0.	0.	10
80	8	28	3	50.	0.	0.	56
81	8	28	1	50.	0.	0.	295
82	8	27	1	50.	0.	0.	711
83	8	25	3	50.	0.	0.	89
84	8	20	3	50.	0.	0.	340
85	8	31	1	40.	0.	0.	56
86	8	29	3	40.	0.	0.	42
87	8	29	1	40.	0.	0.	54
88	8	28	3	40.	0.	0.	22
89	8	28	1	40.	0.	0.	30
90	8	38	6	30.	0.	0.	18
91	8	38	1	30.	0.	0.	82
92	8	30	7	30.	0.	0.	135
93	8	30	3	30.	0.	0.	11
94	8	30	1	30.	0.	0.	99
95	8	29	3	30.	0.	0.	42
96	8	29	1	30.	0.	0.	54
97	8	28	3	30.	0.	0.	56
98	8	29	3	20.	0.	0.	41
99	8	29	1	20.	0.	0.	54
100	8	28	1	20.	0.	0.	30
101	8	38	6	10.	0.	0.	21
102	8	38	1	10.	0.	0.	113
103	8	30	7	10.	0.	0.	135
104	8	30	3	10.	0.	0.	16
105	8	30	1	10.	0.	0.	165
106	8	29	3	10.	0.	0.	41
107	8	29	1	10.	0.	0.	54
108	8	28	3	10.	0.	0.	58
109	8	34	3	4.	0.	0.	98

IV. UNMOVEPED CARGO SUMMARY.

	POE	POD	TYPE	EAT	EDD	RDD	QUANTITY
110	8	33	3	4.	0.	0.	450
111	8	26	1	4.	0.	0.	70
112	8	30	1	0.	0.	0.	24
113	8	28	1	0.	0.	0.	94
114	9	21	3	80.	0.	0.	346
115	9	32	1	70.	0.	0.	968
116	9	31	6	70.	0.	0.	23
117	9	25	6	70.	0.	0.	25
118	9	25	1	70.	0.	0.	18
119	9	20	6	70.	0.	0.	272
120	9	25	1	65.	0.	0.	261
121	9	31	7	60.	0.	0.	57
122	9	31	1	60.	0.	0.	55
123	9	29	1	60.	0.	0.	52
124	9	28	1	60.	0.	0.	28
125	9	27	1	60.	0.	0.	50
126	9	25	1	60.	0.	0.	31
127	9	25	1	55.	0.	0.	261
128	9	38	6	50.	0.	0.	83
129	9	31	7	50.	0.	0.	57
130	9	31	6	50.	0.	0.	486
131	9	31	1	50.	0.	0.	55
132	9	30	6	50.	0.	0.	18
133	9	29	1	50.	0.	0.	52
134	9	28	6	50.	0.	0.	53
135	9	28	1	50.	0.	0.	28
136	9	27	6	50.	0.	0.	13
137	9	27	1	50.	0.	0.	50
138	9	25	6	50.	0.	0.	315
139	9	25	1	50.	0.	0.	151
140	9	20	1	50.	0.	0.	272
141	9	25	1	45.	0.	0.	261
142	9	31	7	40.	0.	0.	57
143	9	31	1	40.	0.	0.	55
144	9	29	1	40.	0.	0.	52
145	9	28	1	40.	0.	0.	28
146	9	27	1	40.	0.	0.	50
147	9	25	1	40.	0.	0.	31
148	9	25	3	39.	0.	0.	740
149	9	25	1	39.	0.	0.	123
150	9	38	6	30.	0.	0.	83
151	9	31	7	30.	0.	0.	57
152	9	31	1	30.	0.	0.	55
153	9	30	6	30.	0.	0.	18
154	9	31	7	20.	0.	0.	57
155	9	38	6	10.	0.	0.	90
156	9	31	7	10.	0.	0.	57
157	9	31	1	10.	0.	0.	55
158	9	30	6	10.	0.	0.	22
159	9	28	1	10.	0.	0.	28
160	9	26	2	6.	0.	0.	69
161	9	26	1	5.	0.	0.	325
162	9	29	1	4.	0.	0.	292
163	9	26	1	4.	0.	0.	244
164	9	23	3	4.	0.	0.	861

IV. UNMOVERED CARGO SUMMARY.

POE	POD	TYPE	EAT	EDD	RDD	QUANTITY
165 10	31	7	60.	0.	0.	76
166 10	31	1	60.	0.	0.	74
167 10	29	1	60.	0.	0.	70
168 10	28	1	60.	0.	0.	39
169 10	27	1	60.	0.	0.	68
170 10	21	1	60.	0.	0.	562
171 10	31	7	50.	0.	0.	76
172 10	31	1	50.	0.	0.	74
173 10	29	1	50.	0.	0.	70
174 10	28	1	50.	0.	0.	38
175 10	27	1	50.	0.	0.	68
176 10	31	7	40.	0.	0.	76
177 10	31	1	40.	0.	0.	74
178 10	29	1	40.	0.	0.	70
179 10	28	1	40.	0.	0.	38
180 10	27	1	40.	0.	0.	68
181 10	33	7	30.	0.	0.	16
182 10	31	7	30.	0.	0.	76
183 10	31	1	30.	0.	0.	74
184 10	29	1	30.	0.	0.	69
185 10	28	1	30.	0.	0.	38
186 10	27	1	30.	0.	0.	66
187 10	33	7	20.	0.	0.	16
188 10	31	7	20.	0.	0.	63
189 10	31	1	20.	0.	0.	74
190 10	29	1	20.	0.	0.	69
191 10	28	1	20.	0.	0.	38
192 10	27	1	20.	0.	0.	65
193 10	29	3	11.	0.	0.	206
194 10	33	7	10.	0.	0.	24
195 10	31	7	10.	0.	0.	63
196 10	31	1	10.	0.	0.	74
197 10	29	1	10.	0.	0.	69
198 10	28	1	10.	0.	0.	38
199 10	27	1	10.	0.	0.	65
200 11	31	7	60.	0.	0.	14
201 11	31	1	60.	0.	0.	113
202 11	29	1	60.	0.	0.	107
203 11	28	1	60.	0.	0.	59
204 11	27	1	60.	0.	0.	103
205 11	31	7	50.	0.	0.	14
206 11	31	1	50.	0.	0.	113
207 11	29	1	50.	0.	0.	107
208 11	28	1	50.	0.	0.	59
209 11	27	1	50.	0.	0.	103
210 11	31	7	40.	0.	0.	14
211 11	31	1	40.	0.	0.	113
212 11	29	1	40.	0.	0.	107
213 11	28	1	40.	0.	0.	59
214 11	27	1	40.	0.	0.	103
215 11	31	7	30.	0.	0.	14
216 11	29	1	30.	0.	0.	106
217 11	28	1	30.	0.	0.	59
218 11	31	7	20.	0.	0.	14
219 11	29	1	20.	0.	0.	106

IV. UNMOVERED CARGO SUMMARY.

	POE	POD	TYPE	EAT	EDD	ROD	QUANTITY
220	11	28	1	20.	0.	0.	59
221	11	31	7	10.	0.	0.	14
222	11	29	1	10.	0.	0.	106
223	11	28	1	10.	0.	0.	59
224	11	20	1	4.	0.	0.	199
225	11	28	1	1.	0.	0.	14
226	12	25	1	65.	0.	0.	174
227	12	33	7	60.	0.	0.	18
228	12	31	1	60.	0.	0.	36
229	12	29	1	60.	0.	0.	34
230	12	28	1	60.	0.	0.	19
231	12	27	1	60.	0.	0.	33
232	12	25	1	55.	0.	0.	174
233	12	33	7	50.	0.	0.	18
234	12	31	1	50.	0.	0.	36
235	12	29	1	50.	0.	0.	34
236	12	28	1	50.	0.	0.	19
237	12	27	1	50.	0.	0.	33
238	12	25	1	45.	0.	0.	174
239	12	33	7	40.	0.	0.	18
240	12	29	1	40.	0.	0.	34
241	12	28	1	40.	0.	0.	19
242	12	33	7	30.	0.	0.	41
243	12	29	1	30.	0.	0.	34
244	12	28	1	30.	0.	0.	19
245	12	33	7	20.	0.	0.	41
246	12	29	1	20.	0.	0.	34
247	12	28	1	20.	0.	0.	19
248	12	31	1	14.	0.	0.	352
249	12	29	3	13.	0.	0.	23
250	12	27	1	13.	0.	0.	45
251	12	33	7	10.	0.	0.	66
252	12	29	1	10.	0.	0.	34
253	12	28	1	10.	0.	0.	19
254	12	29	3	9.	0.	0.	338
255	12	31	1	7.	0.	0.	49
256	12	31	1	4.	0.	0.	17
257	12	27	1	4.	0.	0.	79
258	13	27	1	4.	0.	0.	818
259	13	26	3	4.	0.	0.	337
260	13	26	1	4.	0.	0.	445
261	14	25	1	60.	0.	0.	31
262	14	21	1	60.	0.	0.	50
263	14	25	1	50.	0.	0.	31
264	14	25	1	40.	0.	0.	31
265	14	25	1	30.	0.	0.	31
266	14	25	1	20.	0.	0.	31
267	14	25	1	10.	0.	0.	31
268	14	21	9	4.	0.	0.	1144
269	15	25	3	4.	0.	0.	468
270	15	25	1	4.	0.	0.	1073
271	24	29	1	0.	0.	0.	938
272	24	27	1	0.	0.	0.	938

APPENDIX B

DESCRIPTION OF ROUTINES

This section briefly describes each routine in SAILS. Figure 3 shows the system logic and the event/routine interface.

SAILS (Main Routine)
Named Common Used: none
Subroutines Called: DATAIN, TAKE
Events Stored: n/a

Description:

SAILS calls DATAIN to input necessary parameters and place initial events on the event list. TAKE is called to start event processing.

CONARV
Named Common Use: /CONVOY/, /CONSUM/, /GEN/, /CNTRL/, /SHIPIN/, /PORTIN/, /EVENT/
Subroutine Called: PUT
Events Stored: SHPARV

Description:

CONARV marks the arrival of a given convoy at its delivery theater. All ships in the convoy are released and their respective arrival times at their delivery ports are computed.

CONDPT
Named Common Used: /CONVOY/, /CONSUM/, /GEN/, /CNTRL/, /SHIPIN/, /SHPTYP/
Subroutines Called: PUT, T
Events Stored: CONARV

Description:

CONDPT marks a convoy complete and computes the time to travel to the convoy's dispersing location.

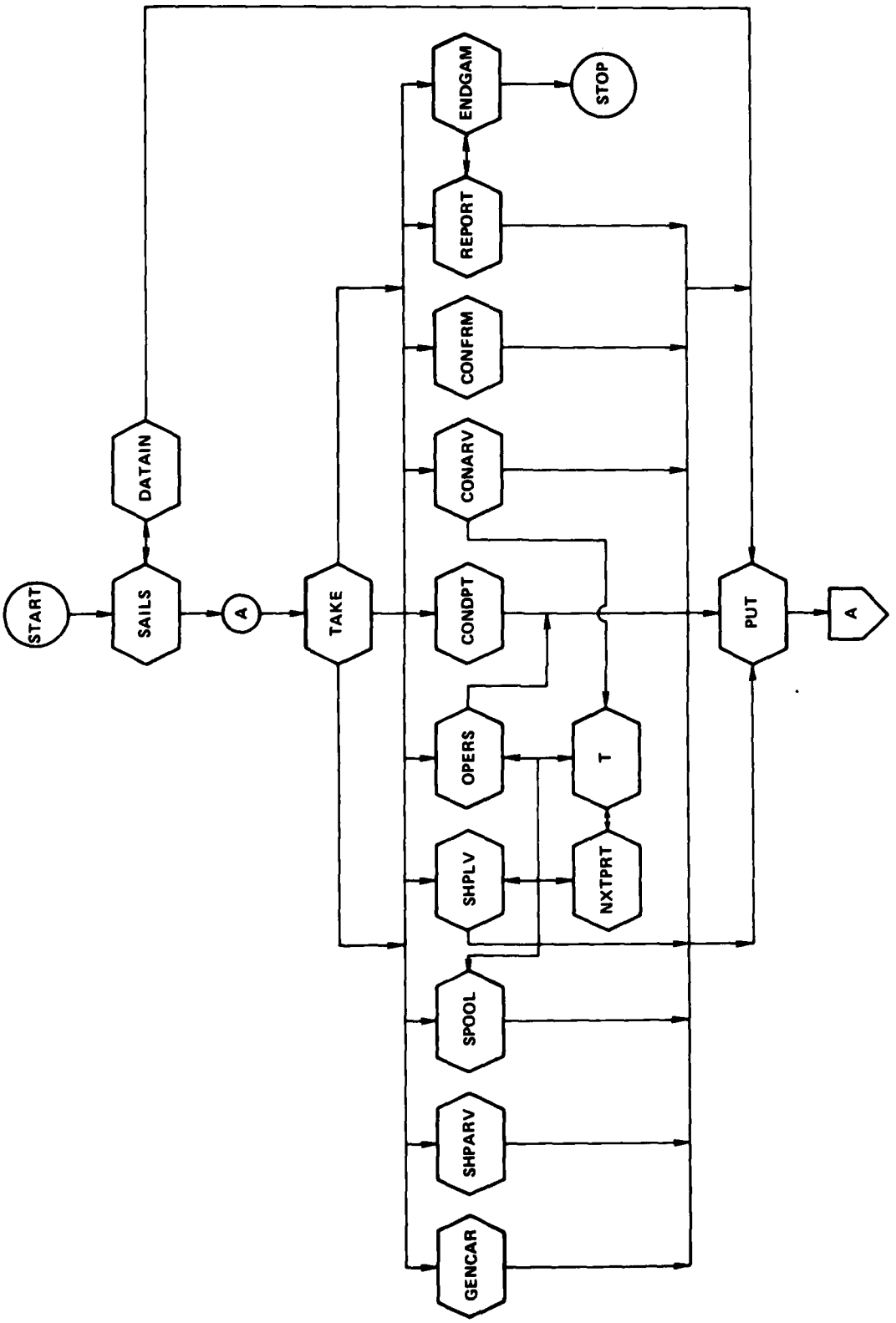

Figure 3 - System Logic Flow Chart

CONFRM

Named Common Used: /CONVOY/, CONSUM, /GEN/, /CNTRL/, /SHIPIN/, /PORTIN/, /EVENT/

Subroutines Called: PUT, T

Events Stored: SHRARV, CONDPT, CONFRM

Description:

CONFRM handles the formation of a convoy. If sufficient ships are available to form a convoy, the convoy is marked complete, and a CONDPT event is stored. Otherwise, the ships individually service their next ports of call.

Subroutine: DATAIN

Named Common Used: /GEN/, /EVENT/, CNTRL, /TIMTAB/, SHIPIN/, SHPTYP/, /CARGOI/, /RATES/, /CSUM/, /SHPS/, /PORTIN/, /QUEUEI/, CONVOY/

Subroutine Called: PUT

Events Stored: GENCAR, ENDGAM, REPORT, SHPARV, SPOOL

Description:

DATAIN inputs all parameters necessary to the simulation and stores the initial events.

ENDGAM

Named Common Used: /GEN/, /CARGOI/, /CONVOY/, /CONSUM/

Subroutine Called: REPORT

Events Stored: none

Description:

ENDGAM ends the simulation. It calls REPORT as a subroutine to process the final simulation reports.

GENCAR

Named Common Used: /GEN/. /CNTRL/, /CSUM/, /CARGOI/

Subroutine Called: none

Event Stored: GENCAR

Description:

GENCAR makes cargo available at its POE. Cargo information is read from the cargo file (TAPE1). Only the cargo available by the given simulation day is processed and stored in linked list format. GENCAR is called each simulation day.

NXTPRT

Named Common Used: /GEN/, /PORTIN/, /CARGOI/, /SHIPIN/, /SHPTYP/

Subroutine Called: T

Events Stored: none

Description:

NXTPRT determines the next port of call for a given ship. If the ship is fully loaded, the next port is determined from the delivery ports of the onboard cargo. Otherwise, the next port is determined from the unmoved cargo.

OPERS

Named Common Used: /GEN/, /CNTRL/, /SHIPIN/, /SHPTYP/, /CARGOI/, /RATES/, /CSUM/, /SHPS/, /PORTIN/

Subroutine Called: PUT

Events Stored: OPERS, SHPLV

Description:

OPERS has two functions. It computes the time to unload and load a given ship and accumulates the amount of cargo moved. When all these computations are complete, a SHPLV event is stored to release port facilities and to reposition the ship at its next port of call.

PUT

Named Common Used: /EVENT/, /GEN/

Subroutine Called: none

Events Stored: none

Description:

PUT places an event on the event list. This list is ordered by event execution time. The next event to be executed is the last entry on the list.

REPORT

Named Common Used: /GEN/, /CNTRL/, /SHIPIN/, /CARGOI/, /PORTIN/, /QUEUEI/, /PORTD/, /SHPS/

Subroutine Called: PUT

Events Stored: REPORT

Description:

REPORT produces the status reports of the simulation. It is processed at a time interval specified by input. REPORT is also called as a subroutine at the termination of the simulation.

SHPARV

Named Common Used: /GEN/, /CNTRL/, /SHIPIN/, /SHPTYP/, /RATES/, /WUEUEI/, /CARGOI/, /PORTD/, /SHPS/

Subroutine Called: PUT

Events Stored: OPERS

Description:

SHPARV marks the arrival of a ship at a port. The berthing facilities needed by the ship are determined. If these facilities are available, the ship begins unloading operations. Otherwise, the ship enters a queue until facilities are available.

SHPLV

Named Common Used: /CNTRL/, /GEN/, /SHIPIN/, /PORTIN/, /SHPTYP/, /QUEUEI/, /PORTD/, /SHPS/, CONVOY/

Subroutine Called: NXTPRT, PUT

Events Stored: SHPARV, CONFRM

Description:

SHPLV releases the berthing facilities used by a departing ship and stores an OPERS event for the next waiting ship. It determines the next port of call and time of arrival for the departing ship. If convoys are considered by the simulation, a CONFRM event is stored to join this ship with a waiting convoy.

SPOOL

Named Common Used: /GEN/, /CNTRL/, /SHIPIN/, /CARGOI/, /PORTIN/, /QUEUEI/, /PORTD/, /SHPS/

Subroutine Called: PUT

Events Stored: SPOOL

Description:

If an excess of backlogged cargo occurs, SPOOL re-activates ships from the pool. It stores a SHPARV event for each re-activated ship to begin shipping operations at the nearest port with excess cargo.

T

Named Common Used: /TIMTAB/, /SHPTYP/

Subroutine Called: none

Events Stored: none

Description:

T computes the travel time in days between two theaters or ports for a specified ship type.

TAKE

Named Common Used: /EVENT/, /CNTRL/, /GEN/

Subroutines Called: GENCAR, SHPARV, OPERS, SHPLV, REPORT, SPOOL, ENDGAM, CONFRM, CONDPT, CONARV

Events Stored: none

Description:

TAKE calls the next event on the event list into execution.

APPENDIX C

VARIABLE DESCRIPTIONS

(I-Integer)
(R-real)

Variable	Common	Mode	Description
NEVENT	/EVENT/	I	Total number of events on list
KEVENT (1000,3)	"	I	Event list
ETIME (1000)	"	R	Event time
LVENT1	/CNTRL/	I	Event pointer
LVENT2	"	I	Event parameter
LVENT3	"	I	"
TEVENT	"	R	Time of event
TIME	/GEN/	R	Current time
NSHIPS	"	I	Total number of ships
NPORTS	"	I	Total number of ports
TINVL	"	R	Time interval between status reports
TTIME (1250)	/TIMTAB/	R	Port distance table, nautical miles
NTHEAS	/TIMTAB/	I	Total number of theaters
INFO (1000)	/CARGOI/	I	Cargo infomration: (POD, cargo type, POE are represented in a packed word format)
NELMTS	"	I	Current number of cargo elements being considered
GTIME (1000)	"	R	Cargo availability time at POE
GEDD (1000)	"	R	Earliest delivery time at POD
GRDD (1000)	"	R	Required delivery time at POD
QUANTY(1000)	"	R	Quantity (mt) of cargo assigned
LFRWD (1000)	/CARGOI/	I	Forward linked list pointer
LBKWD (1000)	"	I	Backward linked list pointer
POE(50)	"	I	Last element assigned with POE
SPTR (1000)	"	I	Linked lists pointer: First element assigned to ship
SHPTY (1000)	/SHIPIN/	I	Ship type
HOME (1000)	"	I	Ship's home/initial port

Variable	Common	Mode	Description
TAVAIL (1000)	"	R	Time available at ship's home port
OWNR (1000)	"	I	Ship owner
SHPMOD (1000)	/SHIPIN/	I	Pool status = 1, ship in pool; otherwise, ship in service
OTHEA (1000)	"	I	Origin theater of ship
DTHEA (1000)	"	I	Delivery theater for ship
INFCO (1000)	"	I	Convoy information for ship:

Convoy type	Convoy number	Next port	Departing port
2d	2d	2d	2d

SPACE (1000)	/SHIPIN/	I	Remaining space available on ship
PRTNAM (50)	/PORTIN/	I	Port name
THEA (50)	"	R	Delay time for entry/exit from port
ADJF (50)	"	R	Loading/unloading adjustment factor
FAC (50,6)	"	I	Number of facilities/berths at port
OMIT (50,16)	/PORTIN/	I	Ship types which cannot use port
PRODUC (6,9)	/RATES/	R	Unloading/loading rates for facilities by cargo type
CCONV (9)	/RATES/	R	Cargo conversion factor from mts to tons
SHPNAM (16)	/SHPTYP/	I	Ship type name
SPEED (16)		R	Speed in knots
CARGO (16)	"	I	Cargo types ship can carry, (packed, 1 digit per type)
FAC1 (16)	"	I	1st facility type preference
FAC2 (16)	"	I	2nd " " "
MTS (16)	"	I	Total cargo (mt) ship can carry
TONS (16)	"	I	Total cargo (tons) ship can carry
SHPSER (50)	/PORTD/	I	Total number of ships serviced at the port
TIMSER (50)	"	R	Total service time at the port (days)

Variable	Common	Mode	Description
QSHIP (50)	"	I	Total number of ships that entered the berth queue at the port
WAIT (50)	/PORTD/	R	Total wait time at the port for berthing facilities (days)
TSEA (1000)	/SHPS/	R	Total time at sea for the ship (days)
TPORT (1000)	"	R	Total time in port for the ship (days)
NSERV	"	I	Total number of ships in service
NPOOL	"	I	Total number of ships in the pool
CGOMOV (1000)	"	I	Total cargo delivered by a ship (mt)
SHPUT (1000)	"	R	Average utilization of ship space
NQ	/QUEUEI/	I	Current number of entries on the queue list
QPORT (50)		I	Entry number on the queue list of the first ship waiting for a berth
QUEUE (500)	"	I	Queue list - ship waiting for facilities
LQFRWD (500)	"	I	Next queue list entry for the berth
LQBKWD (500)	"	I	Prior queue list entry for the berth
MTSP (50)	/CSUM/	I	Quantity of cargo available at a port for shipment (mt)
MTSHP (50)	"	I	Total quantity of cargo shipped from a port (mt)
MTSDEL (50)	"	I	Total quantity of cargo delivered to a port (mt)
NCON (50)	/CONVVS/	I	Current number of convoys in service
MAXC (50)	"	I	Maximum number of ships in a convoy of this type
MINC (50)	"	I	Minimum number of ships in a convoy of this type

Variable	Common	Mode	Description
CWAIT (50)	"	R	Time to build convoy (days)
CROUTE (50)	"	I	Convoy route - packed word:

Delivery theater	Origin theater
2d	2d

CDEL (10)	/CONVOY/	R	Delay time to formation/dismissal location of convoy (days)
CONVOY (100)	"	I	Convoy list - current number of ships in convoy
CTYP (10)	"	I	Corresponding convoy type for convoy list entry
CONTYP	"	I	Total number of convoy types
CATT (10)	/CONSUM/	R	Average travel time for the convoy type
CTOLS (10)	"	R	Total number of ships in this convoy type
CAVS (10)	"	R	Average number of ships in this convoy type
CAVT (10)	"	R	Average convoy formation time for this convoy type (days)
NCONF	"	I	Total number of convoys formed
CTIME (100)	"	R	Start time of convoy formation (days); corresponds to convoy list entry
SPDMIN (10)	"	R	Computed minimum speed (knots) for convoy type
SPDMAX (10)	"	R	Computed maximum speed (knots) for convoy type
SPDA (10)	"	R	Computed average speed (knots) for convoy type

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2. Melton, R., "Ship On-Line Scheduler (SOS) User's Manual," David Taylor Naval Ship Research and Development Center Report DTNSRDC-82/009 (Mar 1982).

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